Smart Technology. Delivered.

Enhanced Class 1 Bluetooth v2.1 Module

HARDWARE INTEGRATION GUIDE
VERSION 1.3

Part # BT740-SA, BT740-SC

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Revision History

Revision	Revision Date	Description
1.0	30 July 2013	Initial Release
1.1	30 Sept 2013	Removed yellow highlights
1.2	19 Dec 2013	Fixed typo.
1.3	06 Feb 2014	Updated Bluetooth SIG Qualification section.

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1 Overview and Key Features

Every BT740 series Bluetooth® module from Laird is designed to add robust, long-range Bluetooth data connectivity to any device. Based on the market-leading Cambridge Silicon Radio (CSR) BC04 chipset, BT740 modules provide exceptionally low power consumption with outstanding Class 1 range via 18 dBm of transmit power. The modules support the latest Bluetooth Version 2.1 specification, including Secure Simple Pairing (SSP), which improves security and enhances the ease of use for end customers. A broad range of Bluetooth profiles such as Serial Port Profile (SPP) and other vital features make BT740 modules superior to other Bluetooth modules.

With a compact footprint of 15.29 x 28.71 mm, the modules deliver maximum range with a minimum size. To ease integration, the modules are designed to support a separate power supply for I/O. Another integration advantage is the inclusion of a complete Bluetooth protocol stack with support for multi-point connections and numerous Bluetooth profiles, including SPP, Human Interface Device (HID) profile, and Health Device Profile (HDP). BT740 modules fully qualify as a Bluetooth End Products, enabling designers to integrate the modules in devices without the need for further Bluetooth qualification.

An integrated AT command processor interfaces to the host system over a serial port using an extensive range of AT commands. The AT command set abstracts the Bluetooth protocol from the host application, saving many months of programming and integration time. It provides extremely short integration times for data-oriented Bluetooth applications.

Included firmware provides programming support for multi-point applications that use up to seven simultaneous data connections to and from the robust BT740 module. A low-cost developer's kit makes it easy for an OEM to integrate the module and guarantees the fastest route to prototype and then mass production.

Features & Benefits

- Bluetooth v2.1 + EDR
- External or internal antennas
- Comprehensive AT interface for simple programming
- Alternate packet based interface for complex programming and up to seven simultaneous connections
- Bluetooth EPL
- Compact footprint
- Class 1 output – 18 dBm
- UART interface with GPIO and ADC lines
- Industrial temperature range
- Field proven firmware used on BTM44x series of modules

Application Areas

- Medical devices
- ePOS terminals
- Automotive diagnostic equipment
- Barcode scanners
- Industrial cable replacement

Bluetooth® Profiles Supported

- Serial Port Profile (SPP)
- Human Interface Device (HID) profile host and device supported
- Health Device Profile (HDP): Agent supported
- IEEE Device Specialization 11073-10415 (Weight Scale)
- IEEE Device Specialization 11073 - 10408 (Thermometer)
- IEEE Device Specialization 11073 – 10417 (Glucose)

2 SPECIFICATIONS

2.1 Detailed Specifications

Table 2-1: Detailed Specifications

Categories	Feature	Implementation
Wireless Specification	Bluetooth®	V2.0
	Frequency	2.402 - 2.480 GHz
	Bluetooth Transmitter Class	Class 1 (Basic Rate BT)
	Max Transmit Power	18 dBm into integrated antenna (BT740-SA) 16 dBm into UFL antenna connector (BT740_SC)
	Min Transmit Power	-9 dBm into integrated antenna -9 dBm into UFL antenna connector
	Receive Sensitivity	Better than -87 dBm (at 25° C)
	Range	>1000m (Line of Sight)
	Data Rates	Up to 1.0 Mbps (over the air)
	UART Data Transfer Rate	Circa 350 kbps
Host Interface	UART	One UART TX, RX, DCD, RI, DTR, DSR, CTS, RTS[1] Default 9600, n, 8, 1 From 1,200 to 921,600 bps
	GPIO	8 configurable lines
	ADC	Two ADC channels 8 bit resolution
	PCM	Not Supported in Firmware (One PCM interface)
Profiles	SPP	Serial Port Profile
	HID	Human Interface Device
	HDP	Health Device Profile
Command Interfaces	Operation Modes	AT Command Set Multi-Point API – seven simultaneous connections
	Firmware Upgrade	Firmware Upgrade over UART
Audio	Support SCO Channels PCM Interface	Not Supported in Firmware
Supply Voltage	Supply	3.0 – 5.0 V On-board regulators and brown-out detection. GPIO voltages are 3.3V logic.

Categories	Feature	Implementation	
Power Consumption	Various Modes – Typical values (see Power Consumption section for test conditions)	Idle mode	1.25 mA
		Discoverable	2.7 mA to 55 mA
		Inquiry mode	65 mA
		Connecting mode	66 mA
		Connected mode (no data transfer)	6 mA
		Connected mode (max data transfer)	35 mA
		Sniff mode	1.8 mA
Antenna Options	Internal	Multilayer ceramic - BT740-SA	
	External	Connection via u.FL - BT740-SC	
Physical	Connections	Surface Mount Pads (1.2mm pitch)	
	Dimensions	15.29 mm x 28.71 mm x 2.5 mm	
	Weight	1.5 g	
Environmental	Operating	-40°C to +85°C	
	Storage	-40°C to +85°C	
Miscellaneous	Lead Free	Lead-free and RoHS compliant	
	Warranty	5-Year Limited Lifetime	
Development Tools	Development Kit	Development kit DVK-BT740 and software tools	
Approvals	Bluetooth®	End Product Listing (EPL)	
	FCC / IC / CE	All BT740 Series	

1. DSR, DTR, RI and DCD are configurable either as GPIO or as modem control lines.

3 HARDWARE SPECIFICATIONS

3.1 Hardware Specifications

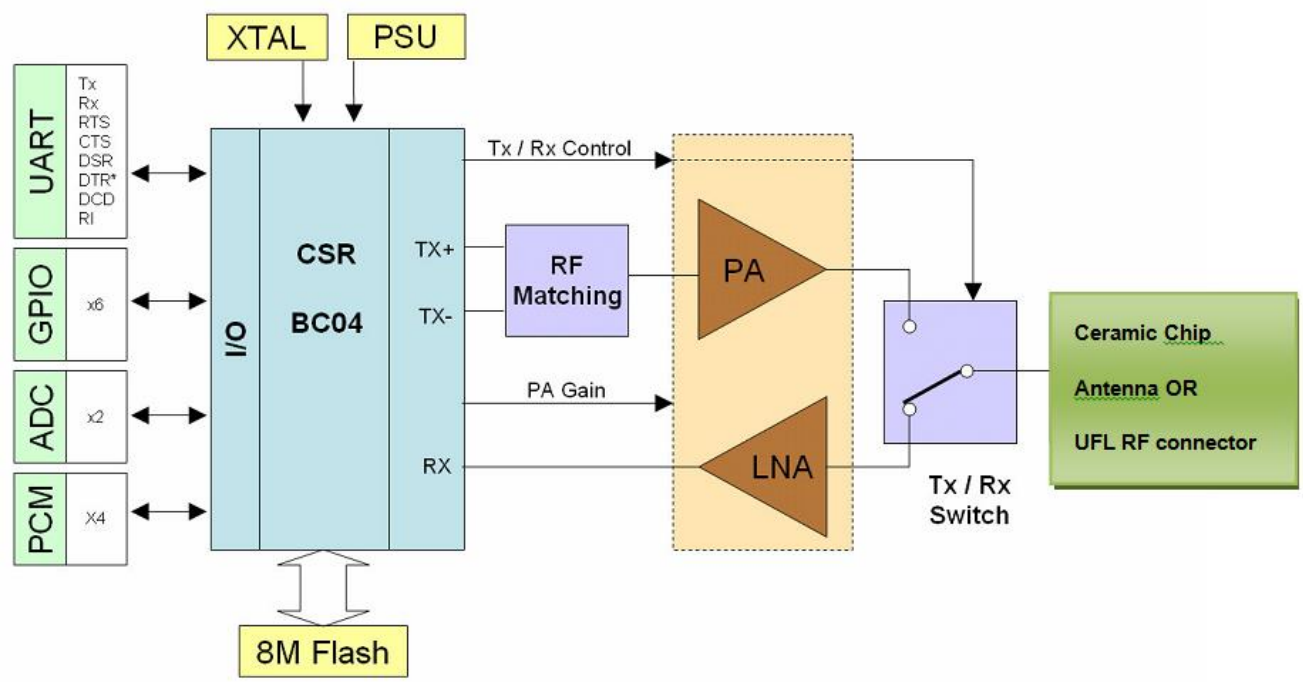


Figure 3-1: Functional Block Diagram

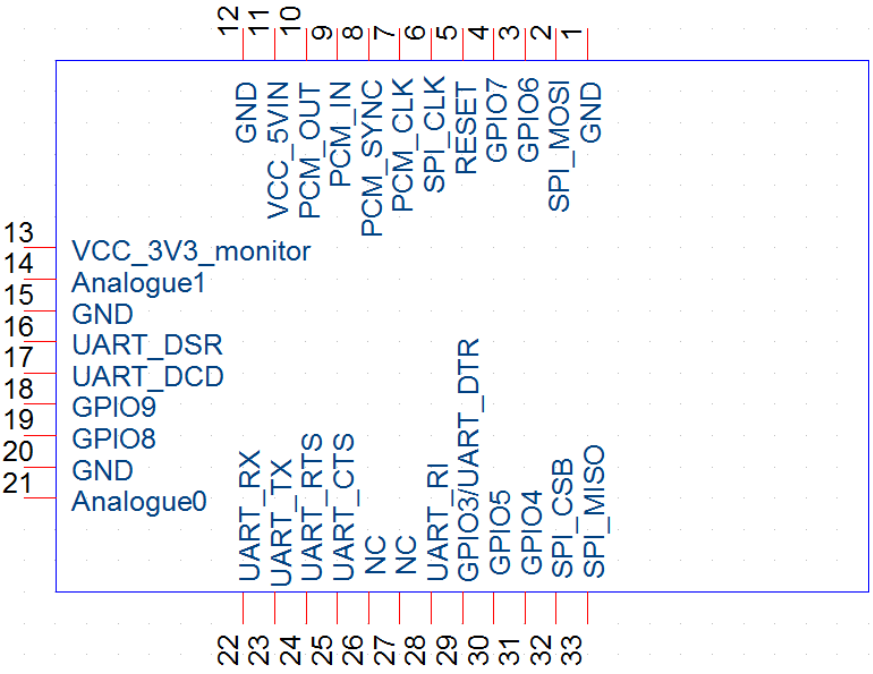


Figure 3-2: BT740-Sx module pin-out (Top View)

3.2 Pin Definitions

Table 3-1: Pin Definitions

Pin	Signal	Description	Comment
1	GND		
2	SPI_MOSI	SPI bus serial I/P	See Note 2
3	GPIO6	I/O for host	
4	GPIO7	I/O for host	
5	nRESET	Module reset I/P	See Note 3
6	SPI_CLK	SPI bus clock I/P	See Note 2
7	NC (PCM_CLK)	PCM clock I/P	See Note 6
8	NC (PCM_SYNC)	PCM sync I/P	See Note 6
9	NC (PCM_IN)	PCM data I/P	See Note 6
10	NC (PCM_OUT)	PCM Data O/P	See Note 6
11	VCC_IN	3.3 V < VCC_IN < 5.0 V	See Note 4
12	GND		
13	VCC_3V3_monitor	3.3 V Monitor (do not connect)	See Note 5
14	Analogue 1	1.8 V max	
15	GND		
16	UART_DSR	UART_DSR I/P	
17	UART_DCD	UART_DCD I/P or O/ P	
18	GPIO_9	I/O for host	
19	GPIO_8	I/O for host	
20	GND		
21	Analogue 0	1.8 V max	
22	UART_RX	Receive data I/P	See Note 7
23	UART_TX	Transmit data O/P	
24	UART_RTS	Request to Send O/P	
25	UART_CTS	Clear to Send I/P	See Note 7
26	NC (Reserved USB_D+)	Not used for AT module variants	
27	NC (Reserved USB_D-)	Not used for AT module variants	
28	UART_RI	Ring Input or Output	
29	GPIO_3/UART_DTR	I/O for host/UART_DTR	
30	GPIO_5	I/O for host	
31	GPIO_4	I/O for host	
32	SPI_CSB	SPI bus chip select I/P	See Note 2
33	SPI_MISO	SPI bus serial O/P	See Note 2

Notes:

1. Unused pins may have internal connections and must not be connected.
2. Pins 2, 6, 32, and 33 (SPI related) are *only* for Laird internal production purposes.
3. Power-on-reset (power cycling and brown out consideration) – The reset circuitry within the BT740 module incorporates a brown-out detector; this may simplify power supply design. The BT430 reset line is an active low input (Input debounced so must be low for more than 5 ms to cause a reset). Upon the application of power, the Power On Reset circuit built into the module ensures that the unit starts correctly. There is no need for an external power reset monitor.

4. Power Supply Consideration – The power supply for the module should be a single voltage source of VCC within the VCC_IN range of 3.3 V to 5.0 V. It must be able to provide sufficient current in a transmit burst. This can rise to 200 mA. To limit dissipation it is recommended that you use a voltage at the lower end of the range.
5. The module includes regulators to provide internal local 3.3 V. This rail is accessible on pin 13 for monitoring purposes only. Under no circumstances should this pin be used to source current.
6. Pins 7, 8, 9 and 10 (PCM related) are NOT supported in Firmware therefore are NC (No Connect) pins.
7. Add a 10 k pull-up to the host PCB on the UART_RX, otherwise the module will remain in deep sleep if not driven to high. Add a 10 k pull-down to the host PCB on the UART_CTS that if it is not connected (which we do not recommend) then the default state for UART_CTS input will be asserted which means can send data out of UART_TX line.
8. GPIO lines can be configured through software to be either inputs or outputs with weak or strong pull-ups or pull-downs. At reset, all GPIO lines are configured as inputs with weak pull-downs.
9. UART_RX, UART_TX, UART_CTS, UART_RTS, UART_RI, UART_DCD, and UART_DSR are 3.3 V level logic. For example, when RX and TX are idle they sit at 3.3 V. Conversely, for handshaking pins CTS, RTS, RI, DCD, and DSR, a 0 V is treated as an assertion.
10. Pin 28 (UART_RI) is active low. It is normally 3.3 V. When a remote device initiates a connection, this pin goes low. This means that when this pin is converted to RS232 voltage levels it has the correct voltage level for assertion.
11. Pin 17 (UART_DCD) is active low. It is normally 3.3 V. When a connection is live, this pin is low. This means that when this pin is converted to RS232 voltage levels it has the correct voltage level for assertion.
12. Pin 16 (UART_DSR) is an input, with active low logic. It should be connected to the DTR output of the host. When the BTM740 module is in high speed mode (see S Register (in AT mode) in the Firmware User manual), this pin should be asserted by the host to ensure that the connection is maintained. A deassertion means that the connection should be dropped or an online command mode is being requested.
13. Pin 13 (VCC_3V3 monitor) may only be used for monitoring purposes. It must not be used as a current source.
14. The GPIO pins can be accessed using S Registers in AT mode and a special command in MP mode. See the Firmware User manual for S-register required.
15. GPIO3 is also used for DTR output (active low). See the Firmware User manual for S-register required.
16. Analogue 0 and 1 should not exceed 1.8 V and see the Firmware User manual for S-register used to access them.

3.3 Electrical Specifications

3.3.1 Absolute Maximum Ratings

Absolute maximum ratings for supply voltage and voltages on digital and analogue pins of the module are listed below.

WARNING: Exceeding the following values causes permanent damage to the device.

Parameter	Min	Max	Unit
Peak current of power supply	0	200	mA
Voltage at digital pins	-0.4	3.7	V
Voltage at POWER pin	2.9 *	6.0	V

3.3.2 Recommended Operating Parameters

3.3.2.1 Power Supply

Signal Name	Pin No	I/O	Voltage level	Comments
VCC_IN	11	I	3.0 V to 5.0 V * Typ 3.5 V	I_{typ} = 115 mA
GND	1, 12, 15, 20			Four (4) ground terminals to be attached in parallel.
VCC_3V3_monitor	13	O	3.3 V typical	For monitoring only. No current source

Note: VCC_3V3_monitor refers to internal voltage generated by the LDO inside the module which is typically 3.3 V. So to achieve 3.3 V for VCC_3V3_monitor (at Max Tx Power) requires VCC_IN of 3.5 V. IO voltage levels follows VCC_3V3_monitor. At minimum VCC_VIN of 3.3 V, the internal LDO generates 3.3 V but when Radio Tx at max Tx power, VCC_3V3_monitor drops a little (to ~3.15 V).

3.3.2.2 Signal Levels for Interface, GPIO (and SPI)

Signal Type	Signal level	Signal level at 0 mA load
Input	VILmin= -0.4V VILmax=0.8V VIHmin=2.3V VIHmax=3.7V	
Output		VOLmax=0.2V VOHmin=3.1V

3.3.2.3 UART Interface

Signal Name	Pin No	I/O	Comments
UART_TX	23	O	
UART_RX	22	I	
UART_CTS	25	I	
UART_RTS	24	O	
UART_DSR	16	I	

Signal Name	Pin No	I/O	Comments
UART_DTR	29	O	Shared with GPIO3
UART_RI	28	I or O	Direction may be programmed.
UART_DCD	17	I or O	Direction may be programmed.

3.3.2.4 SPI Bus

Signal Name	Pin No	I/O	Comments
SPI_MOSI	2	I	INTERNAL USE ONLY - Used to reprogram Flash in Laird production.
SPI_MISO	33	O	
SPI_CSB	32	I	
SPI_CLK	6	I	

3.3.2.5 PCM Interface

Signal Name	Pin No	I/O	Comments
PCM_CLK	7	I or O	These pins are NO CONNECT as they are not supported in the Firmware.
PCM_IN	9	I	
PCM_SYNC	8	I or O	
PCM_OUT	10	O	

3.3.2.6 General Purpose I/O and ADC

Signal Name	Pin No	I/O	Signal level	Comments
GPIO_3 - 9	3, 4, 16, 17, 18, 19, 29, 30, 31	I or O	See Recommended Operating Parameters	
Analogue0, Analogue1	14, 21	I	Range 0 – 1.8 V	8 bit

3.3.2.7 nRESET

Signal Name	Pin No	I/O	Signal level	Comments
nRESET	5	I	V_{IL}max=1.0V V_{IH}min=2.3V	Active LOW. The Reset input contains a 10 kΩ pull-up resistor (internal to module).

4 I/O CHARACTERISTICS

4.1 Power Consumption

The current drain from the VCC power input line is dependent on various factors. The three most significant factors are the voltage level at VCC, UART baud rate, and the operating mode. The hardware specification for the module allows for a voltage range of 3.3 to 5.0 at VCC. The unit includes a linear regulator and tests have shown that there is no significant difference in current draw when VCC changes within the operating limits. Tests have shown that where power dissipation is an issue, it is best to keep VCC at the lower end of the range.

The UART baud rate has a bearing on power dissipation because, as is normal for digital electronics, the power requirements increase linearly with increasing clocking frequencies. Because of this, higher baud rates result in a higher current drain.

The significant operating modes are:

- Idle
- Waiting for a connection
- Inquiring
- Initiating a connection
- Sniff
- Connected

With connected mode, it is also relevant to differentiate between no data being transferred and when data is being transferred at the maximum rate possible. The AT command set document describes how to configure the module for optimal power performance.

4.2 Typical Current Consumption in mA

Table 4-1: Current Consumption

VCC_IN = 3.8 V, Baudrate = 9600 bps Separation Distance = 15 meters (two BT740-SA)	Typical Average Current (mA)
Idle Mode, S512=1	1.25 mA
Wait for Connection Or Discoverable Mode, AT+BTP S508=S510=640, S509=S511=320	55 mA
Wait for Connection Or Discoverable Mode, AT+BTP S508=S510=1000, S509=S511=11	2.7 mA
Inquiry Mode, AT+BTI	65 mA
Connecting Mode (ATDxxx)	66 mA
Connected Mode (No Data Transfer)	6 mA
Connected Mode (Max Data Transfer)	35 mA
Sniff Mode S564=1000, S563=500, S562=50, S561=10	1.8 mA

5 FUNCTIONAL DESCRIPTION

The BT740 Bluetooth module is a self-contained Bluetooth product and requires only power to implement full Bluetooth communication. The integrated, high performance antenna, together with the RF and base-band circuitry provides the Bluetooth link and the UART interface provides a connection to the host system.

The variety of interfaces and the AT command set allow the BT740 module to be used for a wide number of long range wireless applications, from simple cable replacement to complex multipoint applications, where multiple radio links are active at the same time.

The complexity and flexibility of configuration are made simple for the design engineer by the integration of an extremely comprehensive set of AT commands, supplemented with a range of "S" registers which are used for non-volatile storage of system parameters.

To provide the widest scope for integration a range of different physical host interfaces are provided.

5.1 UART Interface

UART_TX, UART_RX, UART_RTS, and UART_CTS form a conventional asynchronous serial data port with handshaking. The interface is designed to operate correctly when connected to other UART devices such as the 16550A. The signalling levels are nominal 0 V and 3.3 V, and are inverted with respect to the signalling on an RS232 cable. The interface is programmable over a variety of bitrates: no, even, or odd parity; stop bit; and hardware flow control. The default condition on power-up is pre-assigned in the external flash. UART_RTS and UART_CTS implement two-way hardware flow control. UART_RTS is an output and is active low. UART_CTS is an input and is active low.

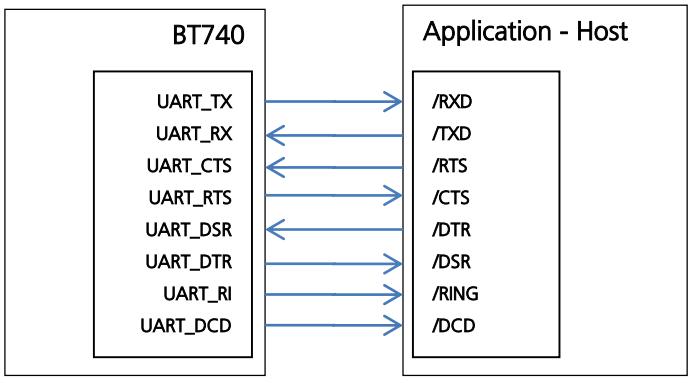
These signals operate according to normal industry convention. UART_RX, UART_TX, UART_CTS, UART_RTS, UART_RI, UART_DCD, and UART_DSR are all 3.3 V level logic. For example, when RX and TX idle, they sit at 3.3 V. Conversely for handshaking pins CTS, RTS, RI, DCD, and DSR, a 0 V is treated as an assertion.

By writing different values to the relevant S register the UART_RI can continuously poll to detect incoming communication. The UART_RI signal serves to indicate incoming calls.

- UART_DSR is an active low input. It should connect to the DTR output of the host. When the module runs in high speed mode (see definition of the required S-register in the Firmware User manual), this pin should assert by the host to ensure a connection maintains. A de-assertion means that the connection should be dropped, or an online command mode is being requested.

The module communicates with the customer application using the following signals:

- Port /TXD of the application sends data to the module's UART_RX signal line
- Port /RXD of the application receives data from the module's UART_TX signal line



Note: The serial module output is at 3.3 V CMOS logic levels. Level conversion must be added to interface with an RS232 level compliant interface.

Some serial applications link CTS and RTS to remove the need for handshaking. Laird doesn't recommend linking CTS and RTS other than for testing and prototyping. If these pins link and the host sends data at the point that the BT740 deasserts its RTS signal, there is significant risk that internal receive buffers will overflow and cause an internal processor crash. This also leads to a connection drop and may require a power cycle to reset. Laird recommends you follow the correct CTS/RTS handshaking protocol for proper operation.

5.2 SPI Bus

The module is a slave device that uses terminals SPI_MOSI, SPI_MISO, SPI_CLK, and SPI_CSB. This interface is used for program firmware updates ONLY at the factory. Laird supplies a PC-based utility to allow a firmware upgrade over the UART port. Laird highly recommends that customers use this method for updating firmware.

Note: The designer should be aware that no security protection is built into the hardware or firmware associated with this port, so the terminals should not permanently connect in a PC application.

5.3 PCM Interface

PCM is not supported in Firmware. PCM interface (PCM_OUT, PCM_IN, PCM_CLK, and PCM_SYNC) exists in HW only.

5.4 General Purpose I/O and ADC

5.4.1 GPIO

Seven lines of programmable bi-directional input/outputs (I/O) are provided that can be accessed either via the UART port or Over-the-Air (OTA) from a second Bluetooth unit. These can be used as data inputs or to control external equipment. By using these in OTA mode, a BT740 module can be used for control and data acquisition without the need for any additional host processor. Each of the GPIO[3:9] ports can be independently configured to be either an input or output. A selection of ports can be accessed synchronously.

The ports are powered from internal VCC_3V3. The mode of these lines can be configured and the lines are accessed via S Registers (see the Firmware User manual).

5.4.2 ADC

The BT740 provides access to two 8-bit ADCs (Analogue 0 and 1). These provide an input range of 0 mV to 1,800 mV, which are read using the S registers (see the Firmware User manual).

Suitable external scaling and over-voltage protection should be incorporated in your design. The module provides five samples per second at the UART with a baud rate of 115,200 or above.

5.5 BT740-SA On-board Chip Antenna Characteristics

The BT740-SA on-board chip monopole antenna radiated performance depends on the host PCB layout.

BT740 carrier board was used for BT740-SA development and antenna performance evaluation. To obtain similar performance, follow the guidelines in PCB Layout on Host PCB for BT740-SA to allow the on-board antenna to radiate and reduce proximity effects due to nearby host PCB GND copper or metal covers.

BT740-SA on-board antenna datasheet can be accessed from the following link:

http://www.acxc.com.tw/product/at3216/AT3216-B2R7HAA_071204.pdf

6 HARDWARE INTEGRATION SUGGESTIONS

6.1 Circuit

The BT740 series module is easy to integrate requiring no external components on the customer's board apart from those required by customer for development and in customers end application.

Checklist (for the schematic):

- VCC_IN – External power source within the operating range specification of BT740-Sx. Add decoupling (or bulk) capacitors for filtering (or reservoir) the external source. Power-on reset circuitry within BT740-Sx series module incorporates brown-out detector, thus simplifying power supply design. Upon application of power, the internal power-on reset ensures module starts correctly.
- AIN (ADC) and GPIO (or UART) pin IO voltage levels – BT73-Sx GPIO voltage levels are at 3.3V (see Notes). Electrical Specifications. Ensure input voltage levels into GPIO pins are at 3.3V voltage levels. Ensure ADC pin maximum input voltage (1.8 V) for damage is not violated.
- UART – Required. Add connector to allow UART to be interfaced to PC (via UART –RS232 or UART-USB).
- UART_RX and UART_CTS – Add a 10 k pull-up to the host PCB on the UART_RX, otherwise the module remains in deep sleep if not driven to high. The pull-up prevents the module from going into deep sleep when UART_RX line is idling.
- Add a 10 k pull-down to the host PCB on the UART_CTS that, if it is not connected (which we do not recommend) then the default state for UART_CTS input will be asserted which means can send data out of UART_TX line.
- nRESET pin (active low) – Hardware reset. Wire out to push button or drive by host. If used, the external reset must be exerted for a minimum of 5 mS. By default, the module is out of reset when power is applied to the VCC_IN pin.

6.2 PCB Layout on Host PCB - General

Checklist (for PCB):

- MUST locate the BT740-SA module close to the edge of PCB (mandatory for BT740-SA for on-board chips antenna to radiate properly).
- Use solid GND plane on inner layer (for best EMC and RF performance).
- Place GND vias as close to module GND pads as possible.
- Unused host PCB area on surface layer can be flooded with copper but place GND vias regularly to connect copper flood to inner GND plane. If GND flood copper underside the module then connect with GND vias to inner GND plane.
- Route traces to avoid noise being picked up on VCC_IN supply, Analogue and GPIO (digital) traces.

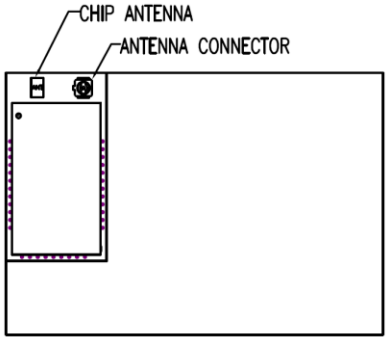
- Ensure there is no exposed copper on the underside of the module (refer to land pattern drawing of BT740-Sx).

6.3 PCB Layout on Host PCB for BT740-SA

6.3.1 Antenna keep-out on host PCB

The BT740-SA has an integrated chip antenna and its performance is sensitive to the host PCB. It is critical to locate the BT740-SA on the edge of the host PCB (or corner) to allow the antenna to radiate properly. Refer to guidelines in the section *PCB Land Pattern and Antenna Keep-out area for BT740-SA*. Some of the guidelines are repeated below.

- Ensure there is no copper in the antenna keep-out area on any layers of the host PCB. Keep all mounting hardware and metal clear of the area to allow proper antenna radiation.
- For best antenna performance, place the BT740-SA module on the edge of the host PCB, preferably in the corner with the antenna facing the corner. An example shown in Figure 6-1.
- A different host PCB thickness dielectric will have small effect on antenna (the BT740 carrier development board (used for antenna performance evaluation) thickness was 0.78 mm).
- The antenna-keep-out defined in *PCB Land Pattern and Antenna Keep-out area for BT740-SA* applies when the BT740-SA is placed in the corner of the host PCB. When BT740-SA cannot be placed as such, you must place it on the edge of the host PCB and use a modified antenna keep out. This antenna keep-out modification is shown in Figure 6-2 (antenna keep-out is extended by 8 mm on both sides).



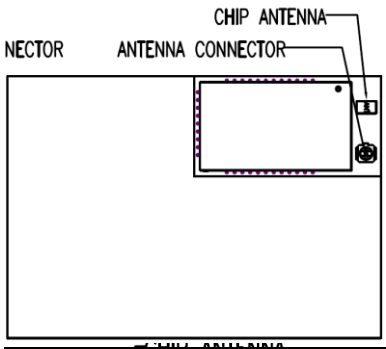
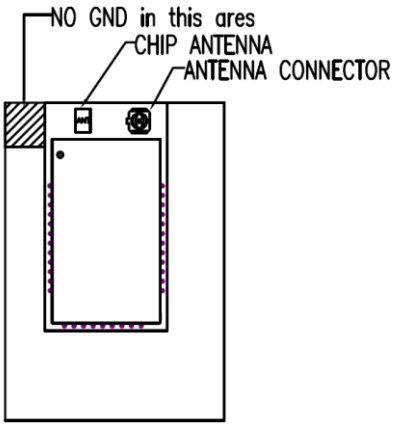


Figure 6-1: BT740-SA placement in the corner of host PCB.



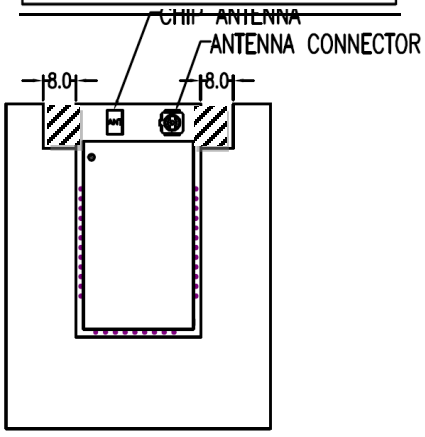


Figure 6-2: BT740-SA placement in the edge (not corner) of host PCB (with modified antenna keep-out).

Note: Copper cut-away on all layers in "antenna keep-out" area under BT740-SA module on host PCB. Refer to "antenna keep-out" defined in *7.4 PCB Land Pattern and Antenna Keep-out for BT740-SA*.

6.3.2 Antenna Keep-out and Proximity to Metal or Plastic

Checklist (for metal /plastic enclosure):

- Figure 12A and 12B shows recommended and not recommended locations for metal with respect to a BT740-SA module on-board antenna.
- Minimum safe distance for metals without seriously compromising the antenna (tuning) is 40 mm top/bottom and 30 mm left or right.
- Metal close to the BT740-SA chip monopole antenna (bottom, top, left, right, any direction) will have degradation on the antenna performance. The amount of degradation is entirely system dependent which means some testing by customer is required (in their host application).
- Anything metal closer than 20 mm starts to significantly degrade performance (S11, gain, radiation efficiency).
- It is best that the customer tests the range with a mock-up (or actual prototype) of the product to assess effects of enclosure height (and material, whether metal or plastic).

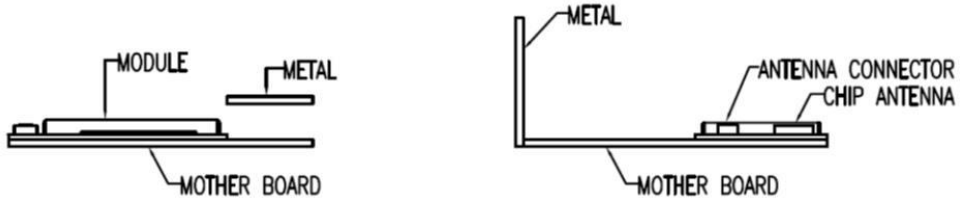


Figure 6-3: Recommended BT740-SA placement on host PCB and proximity to metal cover

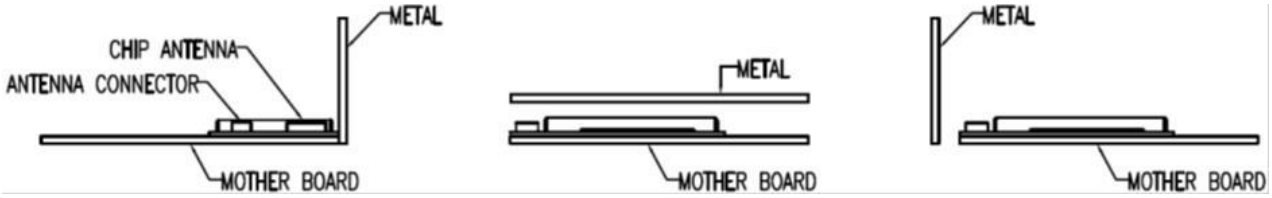


Figure 6-4: Not recommended BT740-SA placement on host PCB and proximity to metal cover

6.4 External Antenna Integration with BT740-SC

Refer to the regulatory sections for FCC, IC, and CE, for details of use of BT740-SC with external antennas in each regulatory region.

The BT740-SC family has been designed to operate with the antennas listed below with a maximum gain of 2 dBi. The required antenna impedance is 50 ohms. External antennas improve radiation efficiency.

Item	Part Number	Mfg.	Type	Gain (dBi)	Connector Type
1	MAF94045	Laird	Internal	2	UFL
2	WRR2400- IP04-B(MAF94019)	Laird	Dipole	1.5	UFL
3	WTC2450-IP04-K(MAF94006)	Laird	Dipole	2	UFL
4	S181FL-L-RMM-2450S	Nearson (Laird)	Dipole	2	UFL

Note 1: Integral RF co-axial cable with UFL connector. Antenna manufacturer Laird contact information: Email: wireless.support@lairdtech.com

7 MECHANICAL DETAILS

7.1 BT740-SC Mechanical Details

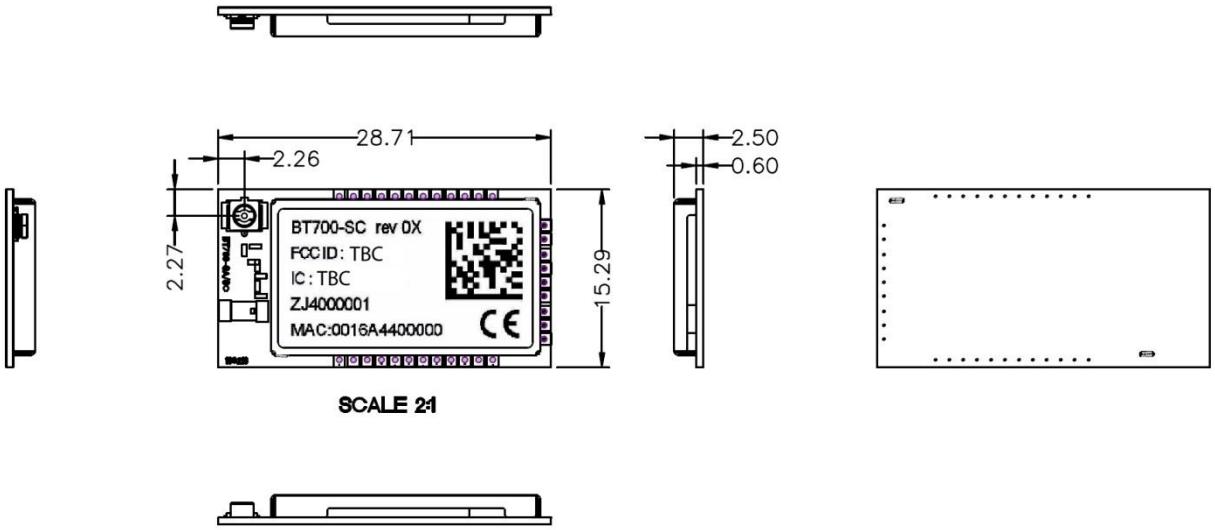


Figure 7-1: BT740-SC mechanical details

7.2 BT740-SA Mechanical Details

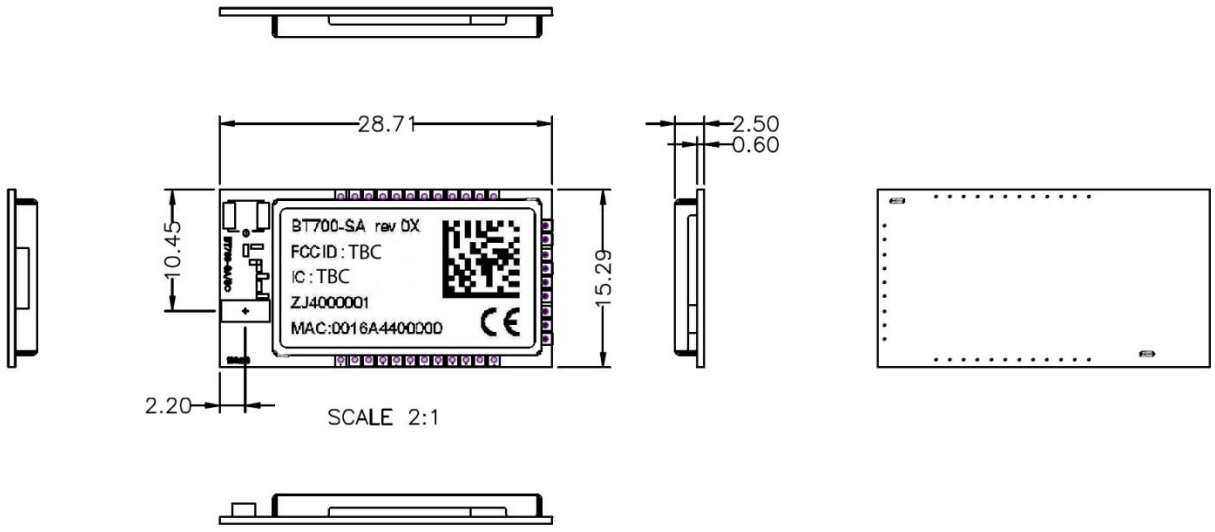
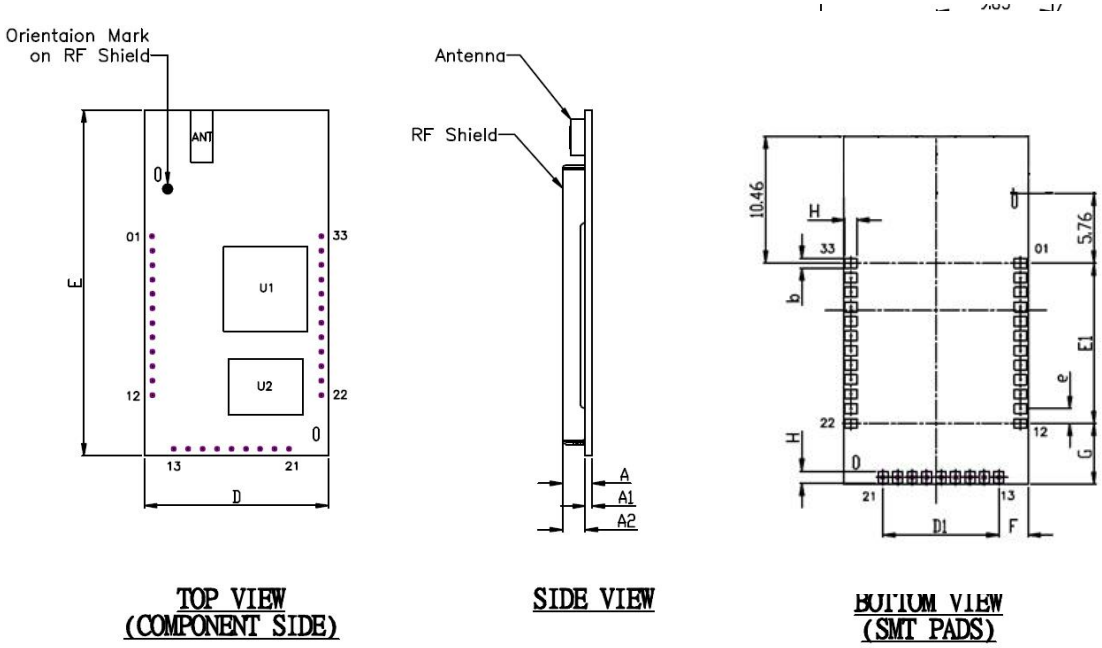


Figure 7-2: BT740-SA mechanical details

7.3 BT740 Pad Definitions – Mechanical Drawing



TOP VIEW (COMPONENT SIDE)

SIDE VIEW

BOTTOM VIEW (SMT PADS)

Description	BT-700			
Size	15.3 x 28.7 x 2.5 mm			
Pitch	1.2 mm			
Demension	Minimum	Typical	Maximum	Notes
A	2.3	2.5	2.7	
A1	0.5	0.6	0.7	PCB Thickness
A2	1.8	1.9	2.0	RF Shield Height
b	0.75	0.80	0.85	Global pad width
D	15.20	15.30	15.40	
E	28.60	28.70	28.80	
e		1.2		Global pitch
D1		9.6		
E1		13.2		
F		2.42		Pad Center to board edge
G		5.05		Pad Center to board edge
H		1.0		Global length of pad to edge of board
Units	mm			

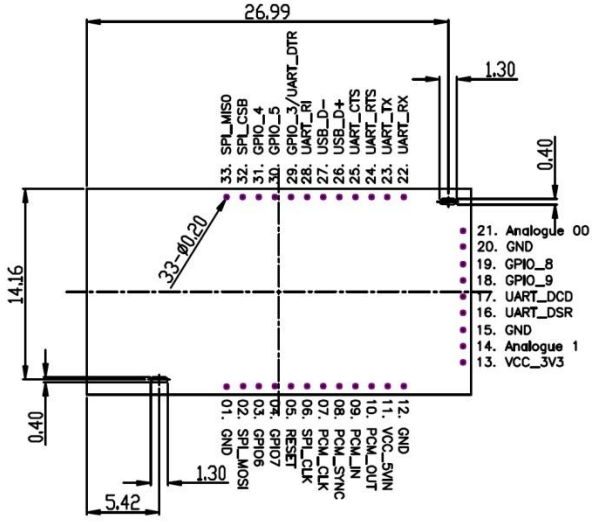


Figure 7-3: BT7xx Mechanical Drawing

7.4 PCB Land Pattern and Antenna Keep-out for BT740-SA

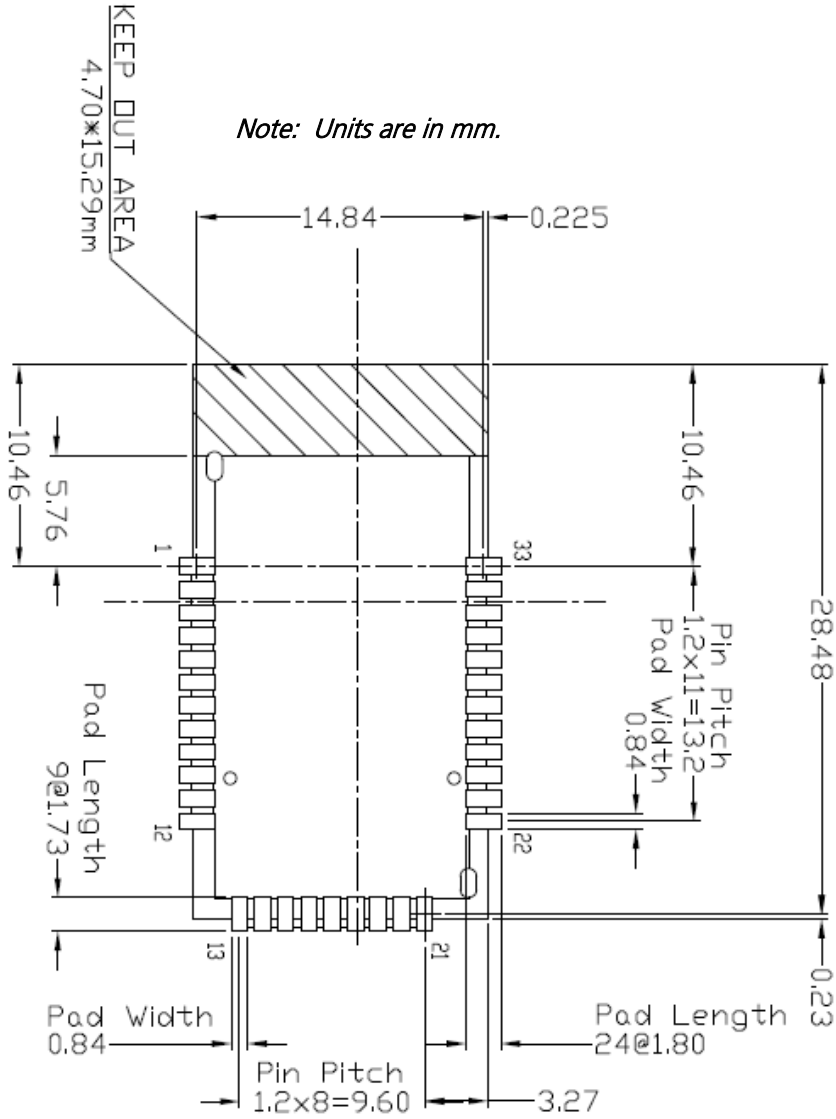


Figure 7-4: PCB Land Pattern and Antenna Keep-out for BT740-SA

APPLICATION NOTES

1. Ensure there is no copper in the antenna 'keep out area' on any layers of the host PCB. Also keep all mounting hardware or any metal clear of the area to reduce effects of proximity detuning the antenna and to help antenna radiate properly. Refer to section 6.3.2 for more information.
2. For BT740-SA (with on-board chip antenna) best antenna performance, the module BT740-SA *must* be placed on the edge of the host PCB, preferably in the **corner** with the antenna facing the corner (see Figure 6-1). The module is placed in the **corner** of host PCB above the keep-out area. If the BT740-SA is placed on the edge instead, the keep-out area must be modified (see Figure 6-2 in section 6.3.1).
3. Ensure that there is no exposed copper under the module on the host PCB.
4. The user may modify the PCB land pattern dimensions based on their experience and capability.

8 SURFACE MOUNT MODULES

8.1 Introduction

Laird surface mount modules are designed to conform to all major manufacturing guidelines. This section provides additional guidance for mounting the module. This section is considered a living document and is updated as new information is presented.

The modules are designed to meet the needs of a number of commercial and industrial applications. The modules are designed to be easily manufactured and conform to current automated manufacturing processes.

8.2 Shipping

Modules ship in Electrostatic Discharge (ESD)-safe trays that can load into most manufacturers pick and place machines. Layouts of the trays are provided in Figure 8-1.

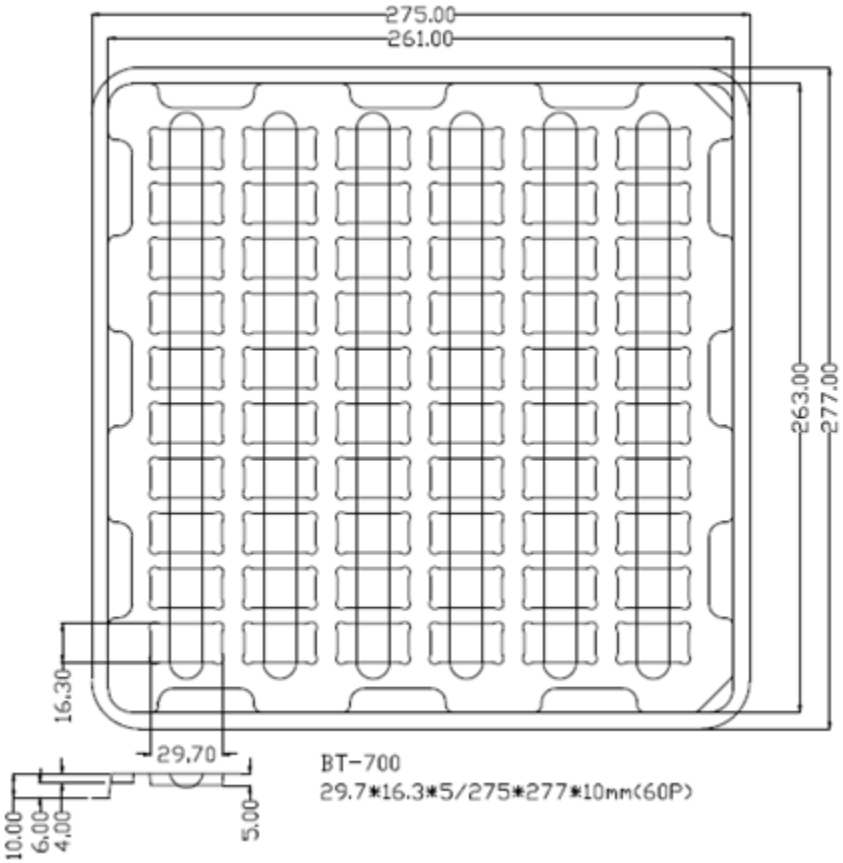


Figure 8-1: BT740 Shipping Tray Details

8.3 Reflow Parameters

Laird surface mount modules are designed to be easily manufactured, including reflow soldering to a PCB. Ultimately it is the responsibility of the customer to choose the appropriate solder paste and to ensure oven temperatures during reflow meet the requirements of the solder paste. Laird's surface mount modules conform to J-STD-020D1 standards for reflow temperatures.

Important: During reflow, modules should not be above 260° and not for more than 30 seconds.

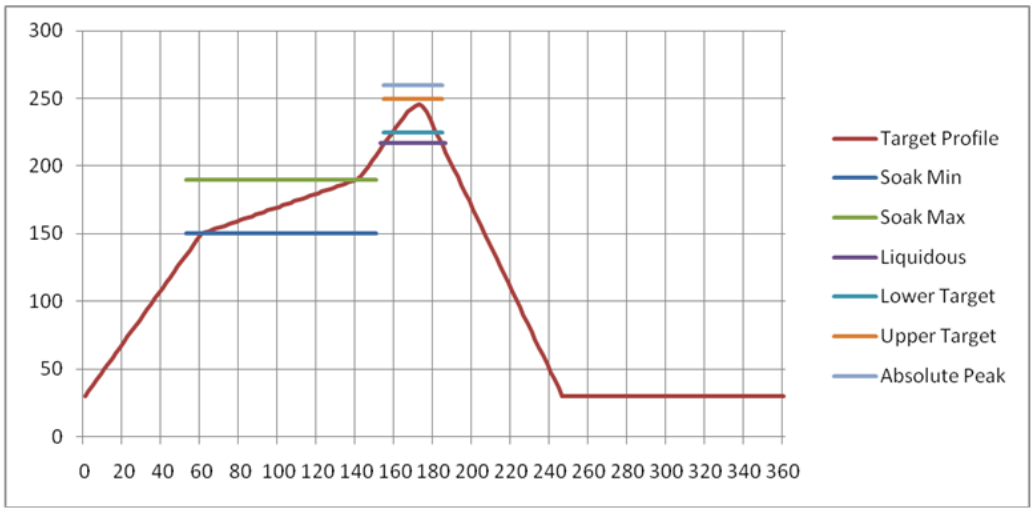


Figure 8-2: Recommended Reflow Temperature

Temperatures should not exceed the minimums or maximums presented in Table 8-1.

Table 8-1: Recommended Maximum and Minimum Temperatures

Specification	Value	Unit
Temperature Inc./Dec. Rate (max)	1~3	°C / Sec
Temperature Decrease rate (goal)	2-4	°C / Sec
Soak Temp Increase rate (goal)	.5 - 1	°C / Sec
Flux Soak Period (Min)	70	Sec
Flux Soak Period (Max)	120	Sec
Flux Soak Temp (Min)	150	°C
Flux Soak Temp (max)	190	°C
Time Above Liquidous (max)	70	Sec
Time Above Liquidous (min)	50	Sec
Time In Target Reflow Range (goal)	30	Sec
Time At Absolute Peak (max)	5	Sec
Liquidous Temperature (SAC305)	218	°C
Lower Target Reflow Temperature	240	°C
Upper Target Reflow Temperature	250	°C
Absolute Peak Temperature	260	°C

9 FCC Regulatory Statements

Family	US/FCC	CANADA/IC
BT7x0	SQGBT700	3147A-BT700

Part #	Form Factor	Tx Output	Antenna
BT740-SA-XX	Surface Mount	18dBm	Ceramic
BT740-SC-XX	Surface Mount	18dBm	U.FL
*Last two slots "XX" in Part # are for production firmware release changes. Can be values 01-99, aa-zz			

The BT740 family is designed to operate with the antennas listed below, with a maximum gain of 2dBi. The required antenna impedance is 50 ohms.

Table 9-1: Qualified Antennas

Item	Part Number	Mfg.	Type	Gain (dBi)
1	AT3216-B2R7HAAT	ACX	Chip	0.5
2	MAF94045	Laird	PCB	2
4	WRR2400- IP04-B(MAF94019)	Laird	Dipole	1.5
5	WTC2450-IP04-K(MAF94006)	Laird	Dipole	2
6	S181FL-L-RMM-2450S	Nearson (Laird)	Dipole	2

Note: The OEM is free to choose another vendor's antenna of like type and equal or lesser gain as an antenna appearing in the table and still maintain compliance. Reference FCC Part 15.204(c)(4) for further information on this topic. To reduce potential radio interference to other users, the antenna type and gain should be chosen so that the equivalent isotropic radiated power (EIRP) is not more than that permitted for successful communication.

9.1 Power Exposure Information

In general, there are two agency classifications for RF radiation exposure in wireless applications: mobile and portable.

Mobile – A mobile device is a transmitting device designed in such a way that a separation distance of at least 20 cm is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons. The BT740 is fully modular approved for mobile and fixed applications (reference FCC Part 2.1091 for further details on mobile devices).

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Portable – Portable is a classification of equipment where the user, in general, is within 20 cm of the transmitting antenna. Portable equipment is further broken down into two classes: within 2.5 cm of human contact and beyond 2.5 cm. The BT740 does not hold a portable approval classification due to its peak output power and modular approval restrictions. Customers who want to use the BT740 in portable applications require further RF evaluation. Contact a qualified test house or a Laird representative for further information on this topic (reference FCC Part 2.1093 for further details on portable devices).

Maximum Permissible Exposure report was created and shows the minimum distances for Public and Occupational use of the BT740.

Note: Occupational Limit Minimum Distance = 1.5 cm. Public Limit Minimum Distance = 3 cm.

Note: This equipment was tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference does not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver
- Connect the equipment to an outlet on a circuit that is different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help

CAUTION: THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES AND INDUSTRY CANADA LICENSE-EXEMPT RSS STANDARD(S). OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS: (1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRED OPERATION.

CAUTION: The OEM should have the device incorporating with the BT740 tested by a qualified test house to verify compliance with FCC Part 15 Subpart B limits for unintentional radiators.

CAUTION: Any changes or modifications not expressly approved by Laird could void the user's authority to operate the equipment.

9.2 OEM Responsibilities

This device is intended only for OEM integrators under the following conditions:

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains FCC ID: SQGBT700".

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

9.3 Industry Canada (IC) Warning:

Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

This device is intended only for OEM integrators under the following conditions: (For module device use)

1. The antenna must be installed such that 20 cm is maintained between the antenna and users.
2. The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

1. L'antenne doit être installée de telle sorte qu'une distance de 20 cm est respectée entre l'antenne et les utilisateurs.
2. Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

NOTE IMPORTANTE:
Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC: .

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: ".

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.
Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

9.4 CE Regulatory

The BT740 has been tested for compliance with relevant standards for the EU market. The OEM should consult with a qualified test house before entering their device into an EU member country to make sure all regulatory requirements have been met for their complete device.

The BT740 was tested with a 2dBi dipole antenna. The OEM is free to use any manufacturer's antenna and type of antenna but it must be ≤2dBi to remain in compliance with the Laird reports.

Reference the Declaration of Conformities listed below for a full list of the standards that the modules were tested to. Test reports are available upon request.

10 EU Declarations of Conformity

10.1 BT740-SA

Manufacturer:	Laird
Product:	BT740-SA
EU Directive:	RTTE 1995/5/EC
Conformity Assessment:	Annex IV

Reference standards used for presumption of conformity:

Article Number	Requirement	Reference standard(s)
3.1a	Health and Safety	EN 60950-1:2006
3.1b	Protection requirements with respect to electromagnetic compatibility	EN 301 489-1 V1.8.1 EN 301 489-17 V2.1.1 Emissions: EN55022:2006/A1:2000/A2:2006(ClassB) Immunity: EN61000-4-2:1995/A1:1998/A2:2001 EN61000-4-3:2002/A1:2002
3.2	Means of the efficient use of the radio frequency spectrum	EN 300 328 V1.8.1 (2012-06)

Declaration:

We, Laird Inc., declare under our sole responsibility that the essential radio test suites have been carried out and that the above product to which this declaration relates is in conformity with all the applicable essential requirements of Article 3 of the EU Directive 1995/5/EC, when used for its intended purpose.

Place of Issue:	Laird Technologies Saturn House, Mercury Park Wooburn Green HP100HH, United Kingdom tel:+44 (0)1628 858 940 fax: +44 (0)1628 528 382
Date of Issue:	June 2013
Name of Authorized Person:	Andrew Dobbing, Engineering Manager
Signature:	

10.2 BT740-SC

Manufacturer:	Laird
Product:	BT740-SC
EU Directive:	RTTE 1995/5/EC
Conformity Assessment:	Annex IV

Reference standards used for presumption and conformity:

Article Number	Requirement	Reference standard(s)
3.1a	Health and Safety	EN 60950-1:2006
3.1b	Protection requirements with respect to electromagnetic compatibility	EN 301 489-1 V1.8.1 EN 301 489-17 V2.1.1 Emissions: EN55022:2006/A1:2000/A2:2006(ClassB) Immunity: EN61000-4-2:1995/A1:1998/A2:2001 EN61000-4-3:2002/A1:2002
3.2	Means of the efficient use of the radio frequency spectrum	EN 300 328 V1.8.1 (2012-06)

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Place of Issue:	Laird Technologies Saturn House, Mercury Park Wooburn Green HP100HH, United Kingdom tel:+44 (0)1628 858 940 fax: +44 (0)1628 528 382
Date of Issue:	June 2013
Name of Authorized Person:	Andrew Dobbing, Engineering Manager
Signature:	

11 BLUETOOTH SIG APPROVALS

11.1 Subsystem Combinations

This application note covers the procedure for generating a new Declaration ID for a Subsystem combination on the Bluetooth SIG website. In the instance of subsystems, a member can combine two or more subsystems to create a complete Bluetooth End Product solution.

Subsystem listings referenced as an example:

Design Name	Owner	Declaration ID	Link to listing on the SIG website
BT740	Laird	B020701	https://www.bluetooth.org/tpg/QLI_viewQDL.cfm?qid=20701
Interface Express subsystem	Cambridge Consultants Ltd	B017578	https://www.bluetooth.org/tpg/QLI_viewQDL.cfm?qid=17578

11.2 Assumptions

This procedure assumes that the member is simply combining two subsystems to create a new design, without any modification to the existing, qualified subsystems. This is achieved by using the listing interface on the Bluetooth SIG website. Figure 11-1 shows the basic subsystem combination of a controller and host subsystem. The controller provides the RF/BB/LM and HCI layers, with the host providing L2CAP, SDP, GAP, RFCOMM/SPP and any other specific protocols and profiles existing in the host subsystem listing. The design may also include a profile subsystem.

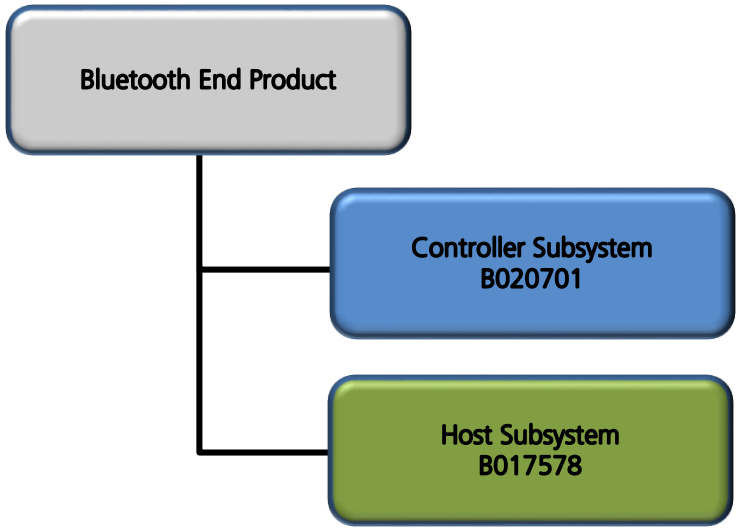

Figure 11-1: Basic subsystem combination of a controller and host subsystem

The qualification process requires each company to registered as a member of the Bluetooth SIG – www.bluetooth.org

The following link provides a link to the Bluetooth Registration page:
https://www.bluetooth.org/login/register/

For each Bluetooth Design it is necessary to purchase a Declaration ID. This can be done before starting the new qualification, either through invoicing or credit card payment. The fees for the Declaration ID will depend on your membership status, please refer to the following webpage:
https://www.bluetooth.org/en-us/test-qualification/qualification-overview/fees

For a detailed procedure of how to obtain a new Declaration ID for your design, please refer to the following SIG document:
https://www.bluetooth.org/DocMan/handlers/DownloadDoc.ashx?doc_id=283698&vId=317486

To start the listing, go to: https://www.bluetooth.org/tpg/QLI_SDoc.cfm

In step 1, select **Reference a Qualified Design** and enter the Declaration IDs of each subsystem used in the End Product design. You can then select your pre-paid Declaration ID from the drop down menu or go to the Purchase Declaration ID page, (please note that unless the Declaration ID is pre-paid or purchased with a credit card, it will not be possible to proceed until the SIG invoice is paid.

Once all the relevant sections of step 1 are complete, complete steps 2, 3, and 4 as described in the help document. Your new Design will be listed on the SIG website and you can print your Certificate and DoC.

For further information please refer to the following training material:
https://www.bluetooth.org/en-us/test-qualification/qualification-overview/listing-process-updates

11.3 Additional Assistance

Please contact your local sales representative or our support team for further assistance:

Laird Technologies Connectivity Products Business Unit

Support Centre: http://ews-support.lairdtech.com

Email: wireless.support@lairdtech.com

Phone: Americas: +1-800-492-2320 Option 2
Europe: +44-1628-858-940
Hong Kong: +852 2923 0610

Web: http://www.lairdtech.com/bluetooth

12 Ordering Information

Part Number	Description
BT740-SA	Enhanced Class 1 Bluetooth V2.1 Module (internal antenna)
BT740-SC	Enhanced Class 1 Bluetooth v2.1 Module (uFL for external antenna)
DVK – BT740-SA	Development board with BT740-SA module soldered in place
DVK – BT740-SC	Development board with BT740-SC module soldered in place

12.1 General Comments

This is a preliminary datasheet. Please check with Laird for the latest information before commencing a design. If in doubt, ask.

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Laird partners with its customers to find solutions for applications in various industries such as:

- Network Equipment
- Telecommunications
- Data Communications
- Automotive Electronics
- Computers
- Aerospace
- Military
- Medical Equipment
- Consumer Electronics

Laird offers its customers unique product solutions, dedication to research and development, as well as a seamless network of manufacturing and customer support facilities across the globe.

globalsolutions: **local** support™

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CONN-HIG-BT740
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